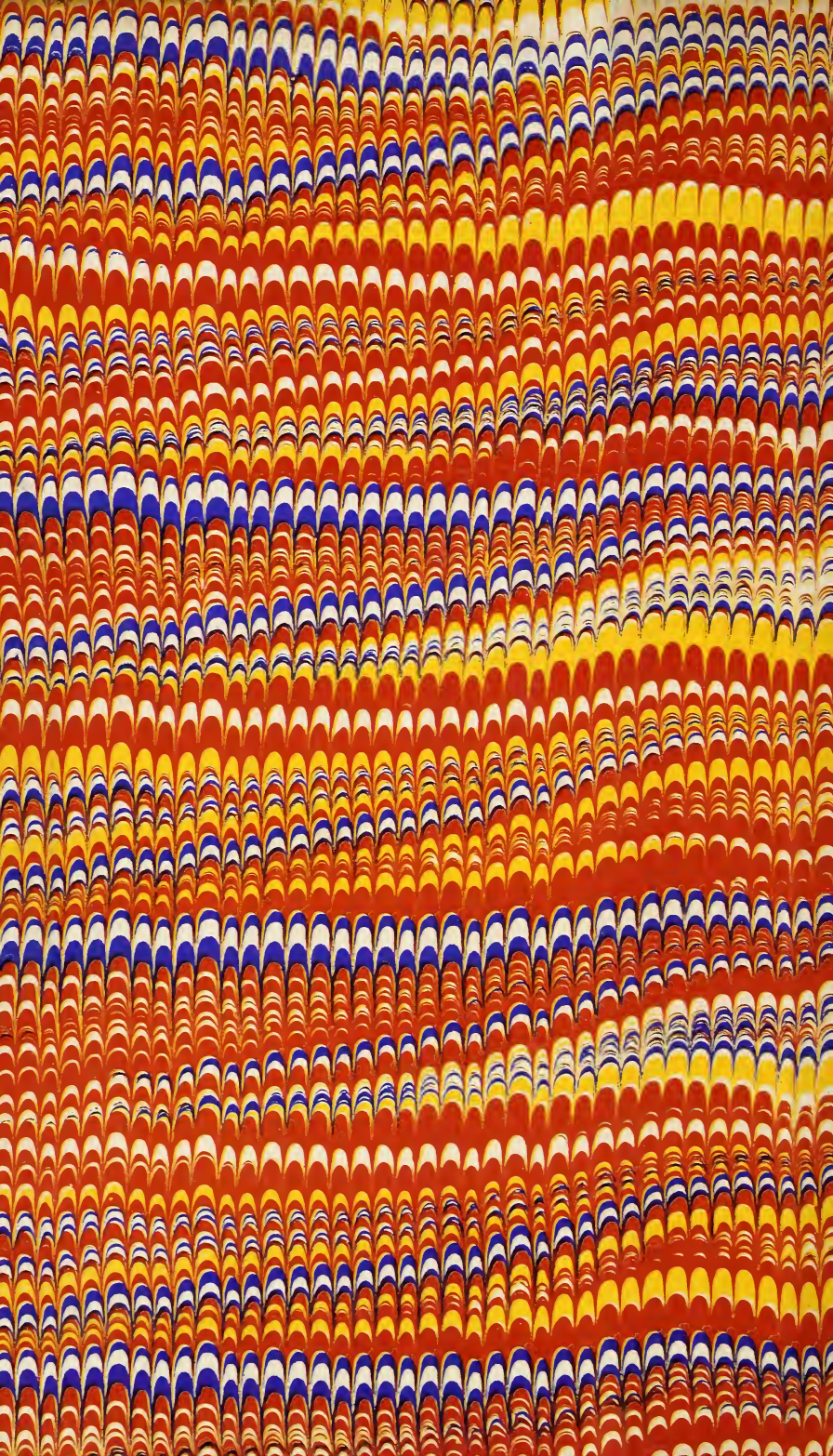
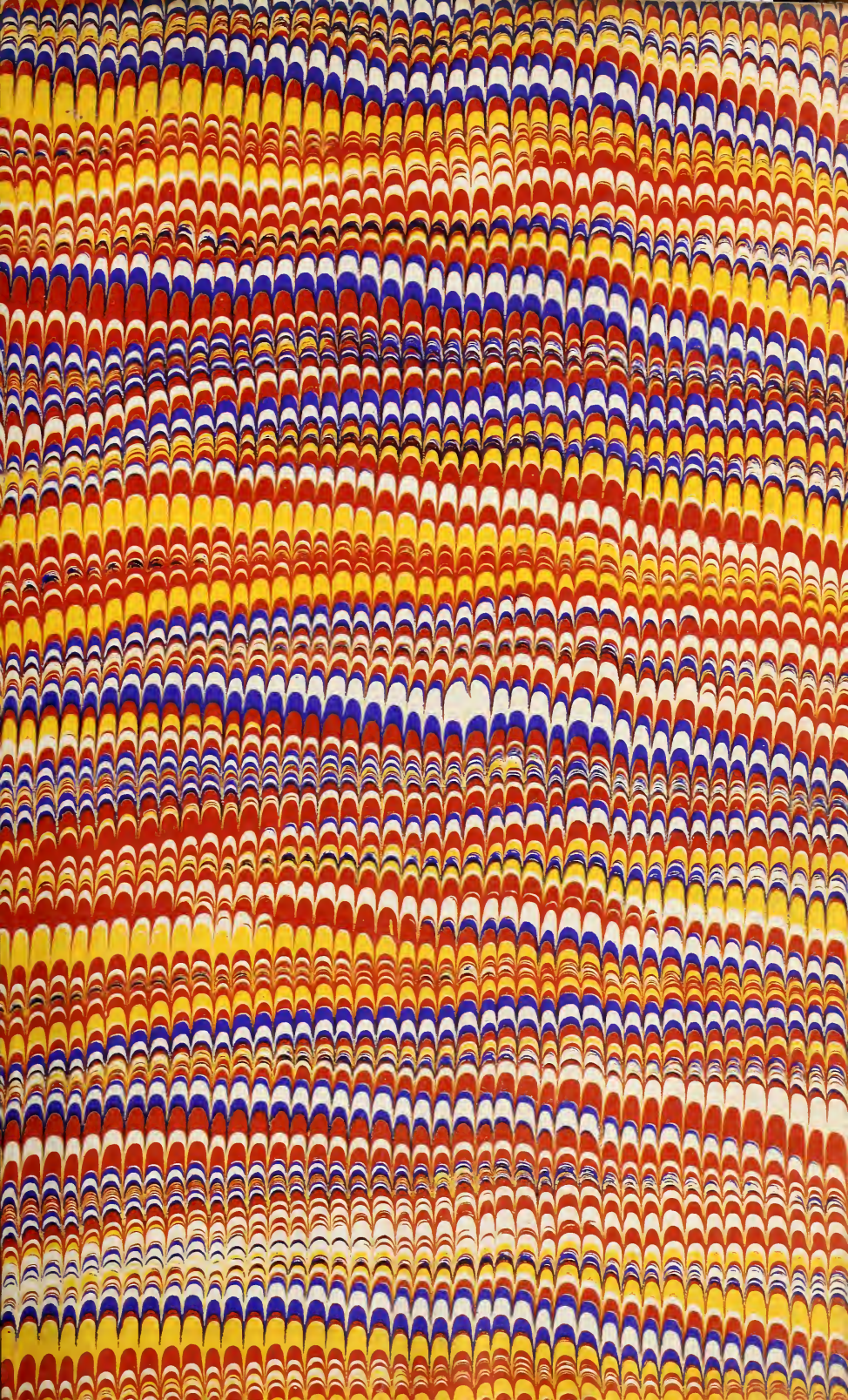




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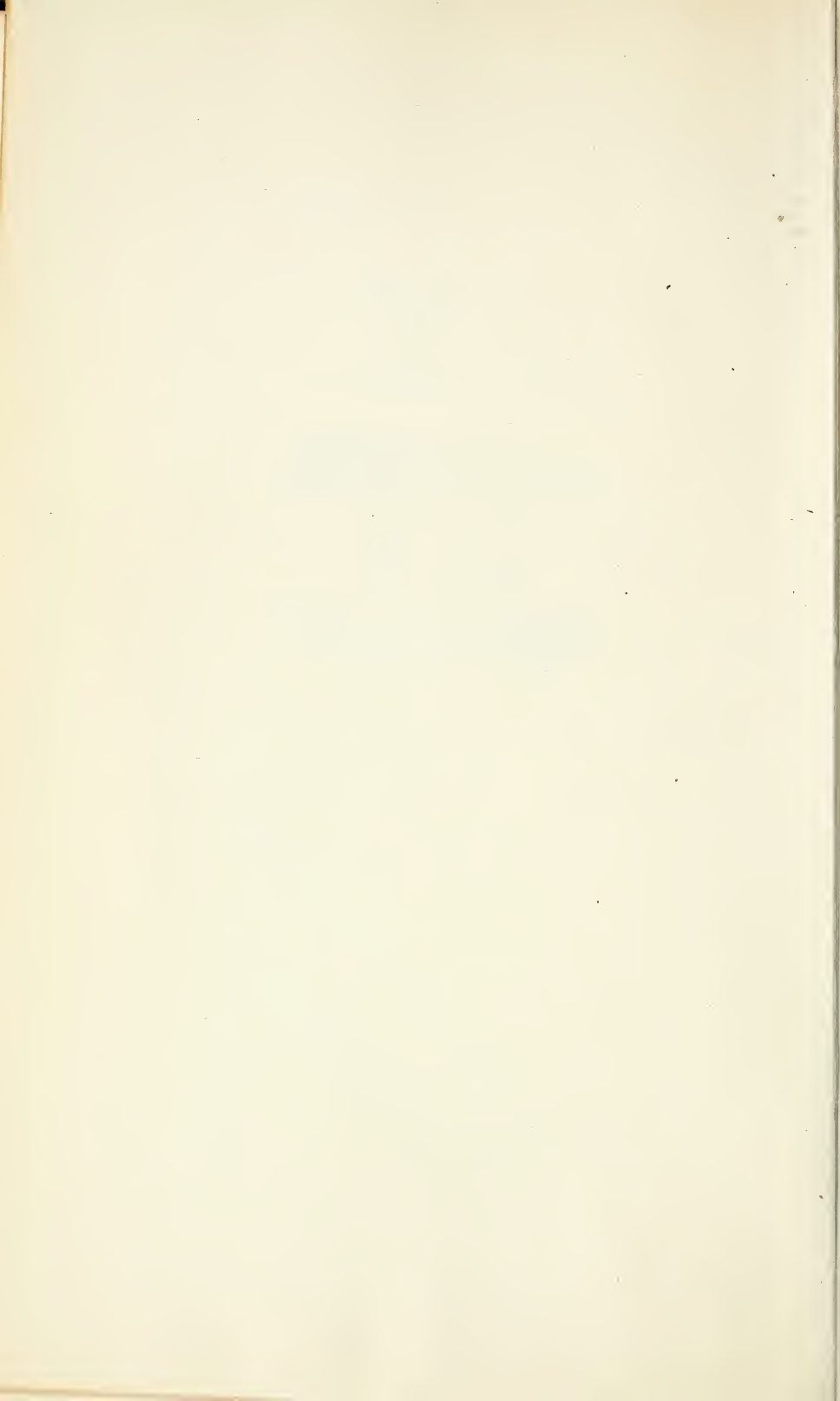
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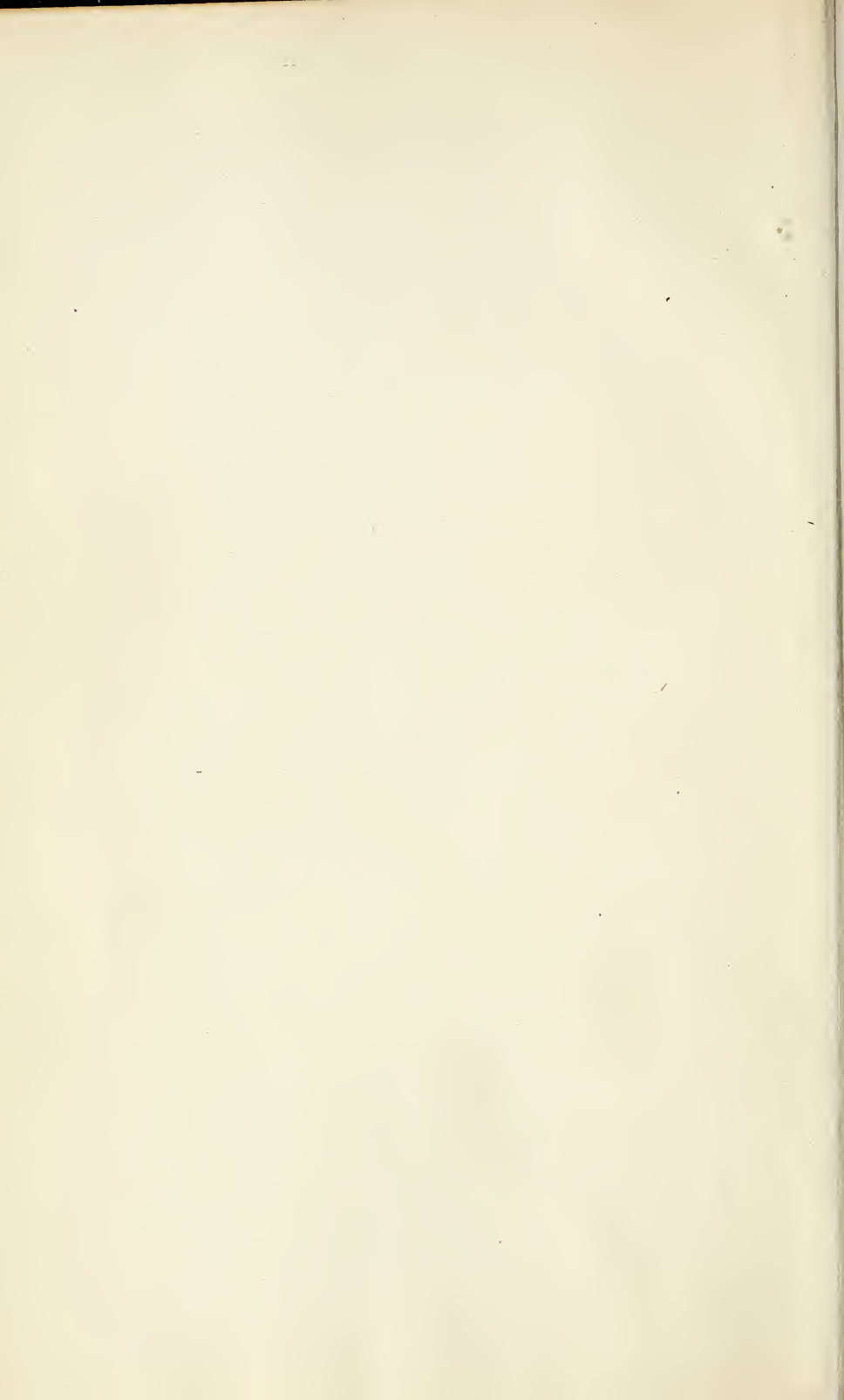
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CIRCULAR No. 401 EXPERIMENT STATION SEPTEMBER 1936
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.



CONTROL OF THE JAPANESE BEETLE AND ITS GRUB IN HOME YARDS¹

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INTRODUCTION

Many people delight in growing flowers, shrubs, fruit, and vegetables in the home yard in the city, suburbs, and country. Unfortunately, from early spring until the approach of winter, these plants are constantly threatened with attack by insect pests and other enemies, and many times they are killed or their value is destroyed. One pest, the Japanese beetle, accidentally introduced into this country some years ago, feeds on many of the plants in the home yard in those parts of the country in which it has become established. This circular is designed to present in brief the information necessary to enable the householder to prevent injury by the Japanese beetle to the various plants. The methods of control presented have been tested and have given satisfactory results. Householders are urged to follow these recommendations rather than those proposed by individuals who have had little experience in controlling this pest.

DISTRIBUTION OF THE BEETLE

The Japanese beetle, known to entomologists under the name of *Popillia japonica* Newman, is a native of Japan. It was first discovered in the United States in Burlington County, N. J., in the summer of 1916. Since that time it has spread by natural means at

¹ This circular is a revision of and supersedes Circular 326, Protecting Plants in the Home Yard From Injury by the Japanese Beetle.

a rate of 5 to 10 miles a year. The area of continuous infestation wherein general injury may occur now comprises southern and central New Jersey, eastern Pennsylvania, northern Delaware, and the District of Columbia. Similar injury is also found locally in parts of Maryland. The beetle has also been found in several places in New England, New York, Ohio, Michigan, Missouri, Indiana, Illinois, Virginia, West Virginia, North Carolina, and South Carolina, but those captured in the more southern and western of these States may have been carried there by train or otherwise a short time before discovery and may thus not represent established infestations.

COOPERATION ESSENTIAL IN CONTROL MEASURES

Within the area of continuous infestation, the Japanese beetle is present in such enormous numbers that the efforts of the individual, without cooperation of his neighbors, may be of little avail against it. The gardeners of a community should cooperate by controlling the Japanese beetle on their own premises and by encouraging and assisting those not yet converted to the use of control measures against this insect.



FIGURE 1.—The adult Japanese beetle. About 4 times natural size.

Cooperative activity is of particular value in localities where few beetles are found, especially at points some distance from the heavily infested area of continuous infestation. The control of any insect pest is more readily brought about when the insect is present in small numbers. A properly organized community campaign against this beetle in the lightly

infested localities should prevent the beetle from increasing rapidly in numbers and may delay indefinitely the time when extensive damage will occur.

DESCRIPTION OF THE BEETLE

The adult Japanese beetle has a very distinctive appearance. It is a brightly colored insect, broadly oval, and about three-eighths of an inch long. It is a brilliant metallic green, except for the greater part of the wing covers, which are reddish bronze. On the sides and tip of the abdomen are 12 tufts of hairs which resemble small white dots (fig. 1).

The immature form of the beetle, commonly referred to as the grub or larva, resembles in general appearance the native white grubs. The grubs vary in size from tiny, recently hatched individuals to those nearly 1 inch long. They are white, with a bluish or blackish cast, which is especially prominent at the rear end, and with

a tan-colored head. They are found in the soil, curled characteristically in the form shown in figure 2.



FIGURE 2.—The grub, or larva, of the Japanese beetle. About 5 times natural size.

NATURE OF ITS INJURY

The adult Japanese beetle has chewing mouth parts. In general, it consumes the tissue between the veins of the leaves and also eats portions of the blossoms and the fruit. The leaves are skeletonized wholly or in part (fig. 3), and the remnants of these leaves soon turn brown and fall. The beetle prefers to feed on the portions of the plant exposed to the direct rays of the sun. It usually begins to feed on the upper and outer portions and works downward and inward. When infestation



FIGURE 3.—Grape leaf showing injury by the Japanese beetle.

is severe, even large shade trees may be completely defoliated within a few days.

The beetle feeds on a large number of plants. It has a marked preference for the foliage and fruit of apple, peach, plum, quince, cherry, raspberry, and blueberry, and the foliage of grapes. Among the shade trees, it is especially fond of linden, chestnut, horsechestnut, sassafras, and elm. The beetle is likely to injure such ornamentals as flowering cherry, flowering quince, flowering peach, spirea, hawthorn, shrub-althea, rose, hollyhock, dahlia, zinnia, hibiscus, and Virginia creeper. In the vegetable garden it has a marked preference for the silk of corn and feeds on the foliage of beans, rhubarb, and asparagus.



FIGURE 4.—A lawn injured by grubs of the Japanese beetle.

The larvae, or grubs, feed on the roots of grasses and legumes, and occasionally they attack the roots of iris, peony, gladiolus, snapdragon, calendula, and other ornamental plants and shrubs. They have been known to feed on the roots of strawberry, corn, bean, tomato, beet, onion, and other vegetable crops. The most serious injury by the grubs is to the roots of grass. The appearance of a lawn suffering from injury by these grubs is similar, in the early stages, to that of a lawn retarded by an inadequate supply of moisture or nutrients. If a portion of the sod is examined and a number of grubs are found, one may be certain that these grubs are causing the damage. As the injury becomes more extensive, the aerial portion of the grass is often completely severed from the roots. Turf which has been killed in this manner, as shown in figure 4, can be rolled back easily by the fingers.

In the latitude of Philadelphia the beetles begin to emerge and feed about the middle of June and are usually most numerous and destructive during the last part of July and the first part of August.

PLANTING PLANS

Under some conditions the most practicable plan for the control of insects is to select for planting those species of plants that are not subject to attack. This cannot always be done, but where a choice is possible, it is wise to choose trees, shrubs, and other ornamentals that are known to be immune or practically immune to severe injury by the adult Japanese beetle. The following plants have been observed to be injured only to a slight extent, or not at all, by this insect. The list, although not complete, is offered as a suggestion.

Fruits: Dewberry, gooseberry,² and pear.

Vegetables: Cabbage, carrot, cauliflower, eggplant, lettuce, onion, parsley, parsnip, pea, potato, radish, spinach, squash, sweetpotato, tomato, and turnip.

Ornamental garden plants: Calendula, carnation, chrysanthemum, columbine, coreopsis, cosmos, gladiolus, goldenglow, iris, larkspur, lily, nasturtium, pachysandra, pansy, peony, petunia, phlox, poppy, snapdragon, sweet pea, tulip, and violet.

Ornamental vines: Clematis, English ivy, honeysuckle, and wisteria.

Ornamental shrubs and trees: Ash, arborvitae, azalea (except deciduous varieties), beautyberry, beech, box, catalpa, chamaecyparis, cypress, deutzia, dogwood, euonymus, fir, forsythia, goldflower, hemlock, hydrangea, juniper, lilac, locust, maple (except Norway maple and Japanese maple), mockorange, oak (except pin oak), pearlbrush, pine, poplar, privet, redbud, rhododendron, snowberry, spirea, spruce, sweetgum, tupelo, and weigela.

TRAP PLANTS OF LITTLE VALUE

It has been observed that in early August, after the height of the beetle season, the beetles may feed to some extent on certain species of geranium (*Pelargonium* spp.) and castor-bean (*Ricinus* spp.) and on the silverbell tree (*Halesia carolina*). Feeding on these plants causes a paralysis beginning with the hind legs of the beetles. Usually one-third to one-half of the paralyzed beetles die. It is not known what constituent of these plants is responsible for this effect. None of these plants are sufficiently attractive to the beetle to induce the insect to leave favorite food plants in the immediate vicinity. On the basis of the present information, these plants are of little value in controlling the beetle under usual field conditions.

REDUCING THE NUMBER OF BEETLES ON THE PREMISES

Any method which is effective in reducing the number of beetles on the premises affords some protection to the plants. These methods should not, however, be used alone but in conjunction with other measures for the protection of plants.

BY JARRING

One of the easiest methods for destroying beetles on heavily infested plants is to shake the plants before 7 a. m. when the tempera-

² Owing to the fact that currant and gooseberry plants propagate and spread the white pine blister rust, the Department recommends against the planting of these bush fruits within 900 feet of white pines and other 5-leaved pines.

ture is low and the beetles are sluggish. The beetles fall to the ground when a plant is jarred under these conditions. Sheets may be spread under the plants to catch the beetles, which may be killed by placing them in a bucket containing water and kerosene.

BY CONTACT SPRAYS

Japanese beetles can be destroyed by a spray which kills by contact. The spray can be applied to low-growing plants in a satisfactory manner by means of one of the hand-power sprayers generally used in gardens (fig. 5). One of the most satisfactory sprays of this type is composed of sodium oleate and an alcoholic extract of pyrethrum flowers diluted with water. Several proprietary sprays containing these ingredients are on the market, and, when used according to the directions, are satisfactory. Sprays containing kerosene are effective in killing beetles, but usually cause damage to foliage and should not be used. If these sprays are not obtainable, commercial fish-oil soap or one of the better grades of household soaps may be used effectively when only a few plants are to be treated. One pound of soap to 3 or 4 gallons of water should be employed on plants in foliage, less water being used if the soap contains much moisture or if the water is hard. It is necessary to dissolve the soap in warm water, taking special care that all solid particles are in solution. It is generally possible to apply these sprays to the hardier plants without causing injury, but continued use of any sprays containing soap is likely to cause some injury to foliage, particularly if the plants are sprayed on hot, humid days.

The effectiveness of a contact spray against the Japanese beetle depends mainly upon the thoroughness with which the insect is wetted. Satisfactory results cannot be obtained unless the insect is completely covered. A few drops of spray on a beetle are not sufficient to kill it. A coarse drenching spray should be used to wet the beetles thoroughly.

The beetle is most susceptible to contact sprays between 10 a. m. and 4 p. m., when the sun is shining, the temperature is above 80° F., and the relative humidity is comparatively low. As the beetles are active and easily disturbed under these conditions, the spray must be applied quickly to drench them. When the weather is cool, or the sky is overcast, or rain is falling, the beetle is not easily killed by contact sprays. It is practically futile to attempt to use these sprays under adverse weather conditions.

Contact sprays, properly applied, will kill a large number of beetles on the foliage at the time of application, but the use of such sprays will not prevent the plants from becoming reinfested and subsequently injured. The beetle is a strong flier and moves readily from one plant to another, so that plants sprayed in the morning may become reinfested again in the afternoon. The usefulness of a contact spray against the Japanese beetle is limited to reducing the number of beetles in the neighborhood.

BY TRAPS

Many millions of beetles have been captured annually since 1925 in metal traps. This is an easy and inexpensive method for destroying large numbers of this insect. Many types of traps are sold commer-

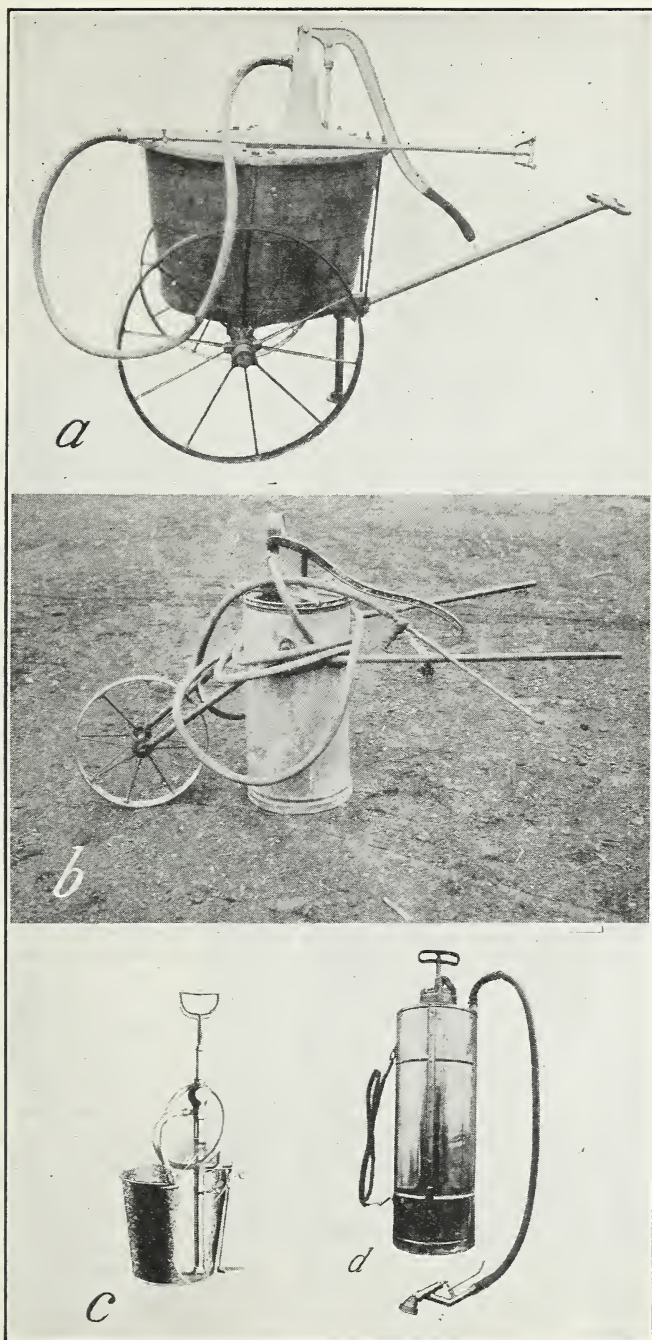


FIGURE 5.—Hand-power sprayers for general use in gardens: *a*, Two-wheel type; *b*, one-wheel barrow type; *c*, bucket pump; *d*, compressed-air type.

cially for this purpose; the most satisfactory results, however, have been obtained with traps similar in construction to the one shown in figure 6. Traps of this type have been purchased singly for \$1 and for considerably less when bought in quantity. With reasonable

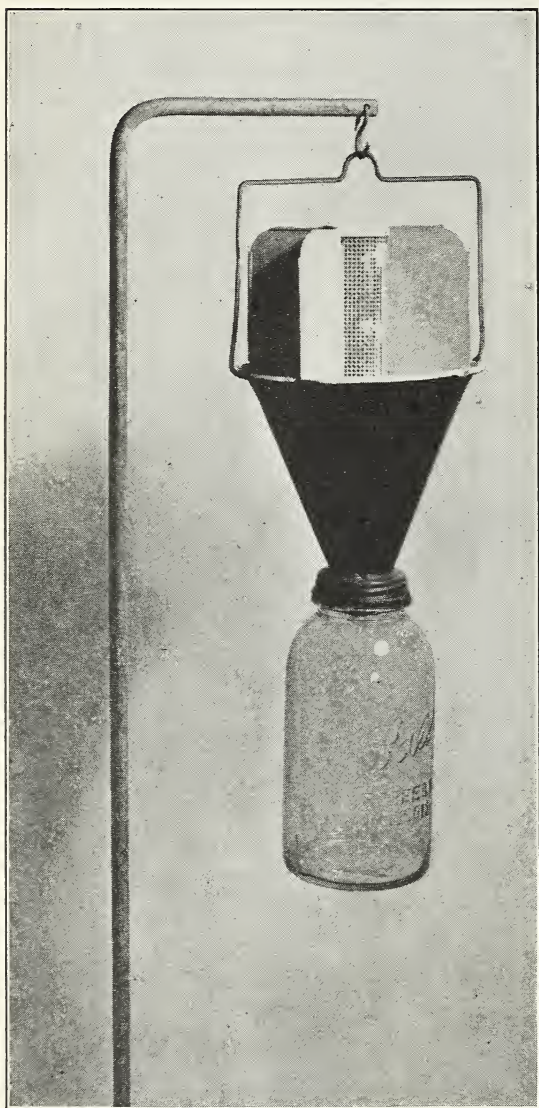


FIGURE 6.—Japanese-beetle trap. The beetles, attracted to the bait, fly to the trap, strike the baffle plates, and drop through a funnel into the glass jar below.

care a substantially made trap will last for 5 to 10 years. The beetles are attracted to traps by a mixture of 10 parts of geraniol and 1 part of eugenol. This mixture will result in the capture of a considerable number of beetles; its effectiveness, however, can be increased at a slight additional cost by the addition of one-half part of phenyl ethyl alcohol. The combination of these materials has been found to be more attractive to the beetle than any other materials known. The bait can be obtained in solid or liquid form, and material for one trap sufficient to last an entire season may be obtained at a cost of from 25 to 50 cents. Bait and traps of the type recommended here are sold at many hardware and seed establishments in New Jersey, eastern Pennsylvania, New York City and suburbs, northern Delaware, and northern Maryland. They are also carried by some department and chain stores in the Philadelphia area.

The attractive power of the trap is governed by the atmospheric conditions. Air currents are necessary to carry the attractive vapors. The traps should, therefore, be placed where the wind will carry the odor of the attractants and draw the beetles from the plants. They

should not be placed closer than 10 feet to the nearest plants, as shown in figure 7; otherwise beetles which are attracted are likely to alight on the foliage. In residential sections, where trees and buildings tend to deflect or impede the movement of air currents, the area of attraction is comparatively small. The larger the number of traps employed in a given area, the greater will be the effect on the beetles in the vicinity.

Traps are particularly valuable in localities where there are few beetles. There is little danger of injury to plants as a result of their use under these conditions, and each female beetle captured under these conditions means a greater reduction of infestation than several thousands taken in the heavily infested districts. As each female

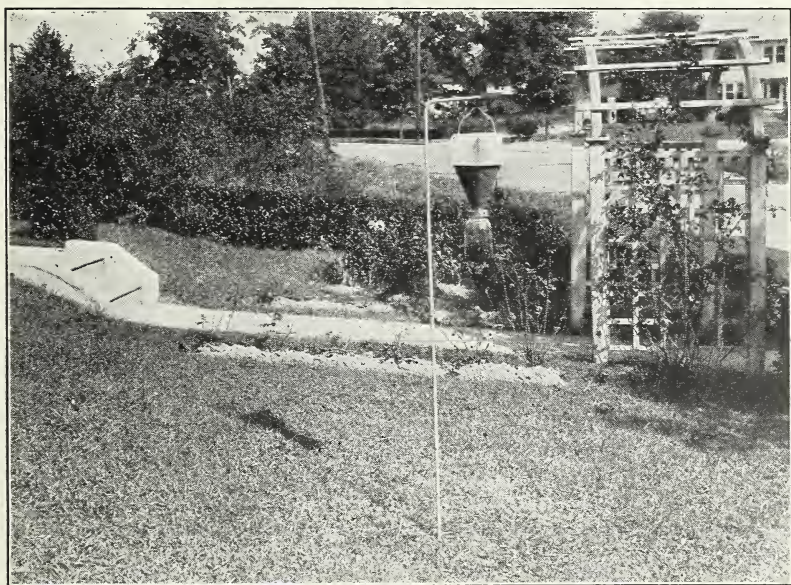


FIGURE 7.—A Japanese-beetle trap properly placed in the home yard.

beetle may lay as many as 40 eggs in one season, it is apparent that the consistent use of traps in lightly infested localities, especially when these are at some distance from the area of continuous infestation, will be of great value in preventing the rapid increase in the number of beetles.

Many thousands of beetles are captured annually by traps in the heavily infested area, but because of the influx of beetles from the surrounding properties there is generally little reduction in the number of beetles on the premises. In some cases the use of traps has not increased the number of beetles on the premises, whereas in other cases traps have drawn in a larger number of beetles. This variation in the effect of the traps is caused, to a large extent, by the conditions under which they are used. Within the heavily infested area traps cannot be depended on to protect favored food plants from attack by the Japanese beetle.³

³For a more complete discussion of the use of traps, see the following publication: METZGER, F. W. TRAPS FOR THE JAPANESE BEETLE AND HOW TO USE THEM. U. S. Dept. Agr. Misc. Pub. 201, 12 pp., illus. 1934. (Revised, February 1936.)

PROTECTION OF SHRUBS AND ORNAMENTALS

PROTECTION OF NONFLOWERING PLANTS

It is possible to protect the foliage of ornamental plants by maintaining a deposit of spray residue on all portions of the plants subject to attack during the period when the beetles are flying. The spray residue largely repels the beetle and prevents extensive feeding, the protection being obtained primarily by making the plant nonattractive rather than by poisoning the beetle. As beetles are repelled from foliage to which any white material has been applied, even though this material is nonpoisonous, it is apparent that foliage can be protected from attack by this insect without danger to children or domestic animals in the home yard. In fact, wherever possible, nonpoisonous insecticides should be used about the home.

Timeliness and thoroughness in the application of repellent sprays are very important. As a general rule, especially in localities where the beetles are very numerous, the first sprays should be applied when the beetles begin to appear in the vicinity and before they become established on the plants. In localities where the infestation is not dense, the first application may be delayed until the beetles begin to appear on the plants to be protected.

For the protection of large trees and shrubs, the householder should have the protective spray applied by means of a high-pressure sprayer of the type now in general use for the control of insects. When the plants are small the protective spray can be applied by the householder with one of the hand-power sprayers such as are shown in figure 5. The most satisfactory protective spray for use by the householder is made by adding 1 pound of hydrated lime and one-quarter pound of aluminum sulphate to 5 gallons of water. The aluminum sulphate should be added to the water and dissolved before the lime is added. In order to obtain the best results it is necessary to keep the mixture agitated during the mixing and spraying, as the lime settles rapidly to the bottom of the container. The residue is not readily washed off by rain, but as later developing leaves will have no protective coating, it may be necessary to make several additional applications throughout the season.

PROTECTION OF FLOWERING PLANTS

A number of flowering ornamental plants are very often subject to attack from the beetles, particularly such plants as rose, hollyhock, shrub-althea, and zinnia. No satisfactory spray has as yet been found for the protection of flowers highly attractive to beetles, as it is not possible to keep the unfolding bloom covered with a protective spray residue. Furthermore, the presence of a white residue on some flowering plants destroys the beauty of the blooms and is often as objectionable as the destruction of the plant.

Roses are especially susceptible to attack. The beetle feeds on the foliage and begins to attack a rosebud when the sepals separate sufficiently to show the color of the petals. The foliage can be very satisfactorily protected by the application of the hydrated lime and aluminum sulphate spray previously mentioned, repeated as frequently as may be necessary to maintain a suitable coating on the

foliage. The buds, however, should be removed as they appear, since it is not possible to protect them from beetle attack. The result of this procedure is that the plants become very vigorous, and when disbudding is discontinued after the beetles have disappeared (about the middle of August) the plants thereafter have a profusion of blooms of excellent quality. It has been found that plants treated in this manner bloom later than ones allowed to flower throughout the summer, with the result that the length of the period when the plant actually is in flower may be curtailed to only a limited extent.

Individual roses, or groups of roses, can be protected by enclosing them with a cloth or wire netting. Frames for holding the netting can be constructed of wood or metal at moderate cost. Several growers of choice roses have successfully protected their flowers by this method. When plants are protected in this manner it may be necessary to apply a fungicide during July and August, because

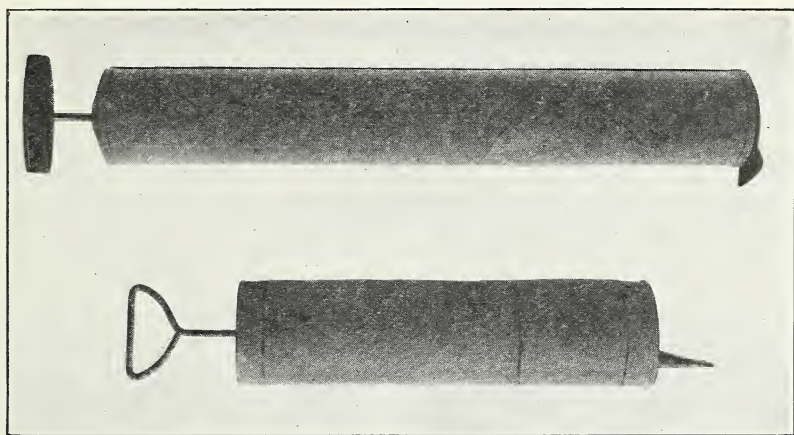


FIGURE 8.—Types of small hand dusters suitable for backyard gardens.

enclosed plants appear to be more subject to mildew than plants grown in the open.

Even though the lime-aluminum sulphate spray leaves a conspicuous residue, it is the only spray which can be recommended at the present time that will afford some protection to flowering plants such as hollyhock, shrub-althea, and zinnia.

PROTECTION OF VEGETABLES

Sweet corn is severely injured by the adult beetle. The chief injury results from the feeding of the adult beetles on the silk as it grows from the husk, before pollination has occurred. Since the destruction of the green immature silk prevents pollination, the silk must be protected from attack until pollination has taken place.

Corn can be protected by dusting the tips of the ears with very fine (300-mesh) hydrated lime when the plants begin to show silk, using a hand duster similar to those shown in figure 8. The application should be made before the beetles begin to accumulate on the ears. Following the first application, at least two additional

applications should be made at intervals of 3 days. The effectiveness of this treatment depends almost entirely upon placing the lime at the proper time on the tips of the ears; the need of extreme care in the application cannot be overemphasized.

The foliage of string and lima beans, rhubarb, and asparagus can be protected by spraying with the hydrated lime-aluminum sulphate spray.

PROTECTION OF FRUIT⁴

SMALL FRUITS

There is no satisfactory procedure for protecting raspberries, blackberries, and blueberries from injury until after the fruit is harvested. It is practically impossible to remove the spray residue from these berries without damaging them. After the fruit is picked, the foliage can be protected by applications of lime.

GRAPES

Bearing and nonbearing grapevines can be protected by spraying with the lime and aluminum sulphate spray. The Japanese beetle does not feed on the fruit. The spray should be directed downward from above to avoid excessive residue on the fruit at the time of harvest, but every leaf should be covered. Additional applications of the spray are usually necessary to protect the new growth that develops subsequent to the initial spraying.

TREE FRUITS

It is practically impossible for the householder to spray the foliage of fruit trees thoroughly with the ordinary garden spraying equipment. When there are several fruit trees to be sprayed, it would be advisable to arrange with a local department, civic organization, or commercial orchardist to apply the different sprays required to protect the fruit from insects and disease. It is practically impossible to protect apples and peaches that ripen during July and early August from attack by the Japanese beetle. The riper fruit is attacked first by the beetles, and when the infestation is relatively light the damage may be confined to these riper fruits. The cherry crop is usually harvested before the beetles appear in sufficient numbers to cause damage to the fruit. Small power sprayers suitable for spraying fruit trees are on the market. When the householder has such equipment, he can protect late apples, late peaches, plums, and the foliage of cherry trees after harvest, by spraying the trees thoroughly with the lime and aluminum sulphate spray.

PROTECTION OF LAWNS

It is possible to make an established lawn practically immune to injury by grubs of the Japanese beetle by applying commercial acid lead arsenate. It is better to prevent injury to the grass by applying the poison before the density of the larval population is sufficient

⁴Further information on the protection of orchard and shade trees from injury by this insect is given in the following publication: FLEMING, W. E., and METZGER, F. W. CONTROL OF THE JAPANESE BEETLE ON FRUIT AND SHADE TREES. U. S. Dept. Agr. Circ. 237. Revised 1936.

to cause damage, but if this has not been done, treatment should be made as soon as injury becomes apparent. The lead arsenate should be uniformly distributed over the lawn at the rate of 10 pounds to 1,000 square feet. The application of smaller quantities of the poison will be of some value in killing the grubs, but in some conditions has afforded no satisfactory protection to the grass.

In some localities the householder can secure mixtures of lead arsenate and organic fertilizers that are prepared for the control of these grubs in grass. When these mixtures are not available, the commercial acid lead arsenate, in powder form, can be used. These small quantities of lead arsenate must be diluted to a greater bulk in order to obtain a uniform distribution over the surface. The material may be mixed with about 25 times its volume of moist sand, soil, or other suitable material and broadcast by hand. If the lawn is well watered with the hose after the treatment has been applied to wash the poison into the ground, there is practically no hazard to children and domestic animals.

A treated lawn should not be injurious to birds because they will not be attracted to it after the treatment has killed most of the worms and larvae in the soil. The extensive use of lead arsenate within the infested area has not caused any known damage to native birds which feed on larvae and worms.

Caution.—The use of lead arsenate about the home yard demands careful attention. Lead arsenate is poisonous to man and animals. Care should be exercised in handling it. It may be mixed and otherwise manipulated with the bare hands, but, since it is possible that the poison may be absorbed into the system through cuts and abrasions of the skin, it is advisable to protect the hands. The worker should keep the hands away from the mouth and wash them thoroughly before eating. It is advisable to make sure that no lumps of the material are left in the grass where they may be eaten by dogs, cats, or poultry, and that any excess material is stored under conditions where it is not accessible to children and animals.

After the treatment has been applied to a lawn, the normal operations of mowing, watering, and fertilizing can be carried on as usual. Lime should be used on poisoned grass only when necessary to correct the acidity of the soil. The addition of hydrated lime, or stone lime, except for the purpose mentioned above, is not recommended because this material has been found to reduce the effectiveness of the insecticidal treatment.

It is difficult to predict how long a lawn treated in this manner will remain immune to injury by grubs of the Japanese beetle, as this will depend on the number of beetles in the vicinity, the type of grass, and the condition of the soil. It is anticipated that under average conditions this treatment will protect a lawn for at least 5 years.⁵

The treatment of a lawn does not, of course, preclude the emergence of adult beetles during the summer from untreated areas in the vicinity and their flight to plants growing on or near the treated grass.

⁵ For further information on the treatment of lawns for protection against this insect see the following publication: FLEMING, W. E. PREVENTING INJURY FROM JAPANESE AND ASIATIC BEETLE LARVAE TO TURF IN PARKS AND OTHER LARGE AREAS. U. S. Dept. Agr. Circ. 403. 1936.

The effectiveness of the treatment should not be judged by the presence of beetles on plants in the vicinity but entirely on the condition of the treated grass.

CONTROL OF THE GRUBS, OR LARVAE, IN FLOWER BEDS AND GARDENS

The grubs of the Japanese beetle are generally not sufficiently numerous in flower beds and vegetable gardens to cause appreciable damage to the roots of the plants. Occasionally the roots of flowering plants such as calendula, rose, dahlia, peony, and snapdragon, and garden crops such as strawberry, beet, onion, and bean, are injured.

The use of acid lead arsenate is not recommended in flower beds, shrubbery borders, or vegetable gardens, as the available evidence shows that some of the ornamentals will not grow in soils containing this material. Many of the vegetables will grow in land treated with lead arsenate, but enough of the poison may be absorbed by the roots to be detrimental to health.

When the infestation is heavy enough to warrant treatment, the larvae can be destroyed by applying carbon disulphide emulsion to the soil. The most satisfactory carbon disulphide emulsion for use by the householder is composed of—

	<i>Parts by volume</i>
Rosin fish-oil soap.....	1
Water.....	3
Carbon disulphide.....	10

The soap and water are placed in a closed container and agitated until the mixture is uniform. The carbon disulphide is added and the agitation continued until the mixture becomes creamlike. One quart of this mixture is added to 50 gallons of water and applied to the infested ground at the rate of 3 pints to a square foot of surface. For small areas this liquid may be applied with an ordinary sprinkling can.

Caution.—Carbon disulphide is a dangerous chemical. The vapor when mixed with air is inflammable. It should be kept away from fire of all kinds. Lighted cigars, cigarettes, or pipes should never be carried when handling this material. Exercise the same caution as when handling gasoline.

Turning the soil late in fall, or carefully working it in the spring and killing the larvae that are found, or permitting chickens to run in the garden until seeding time, are also useful in reducing the number of larvae in the garden.

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